Evaluation of 3D printing filaments for construction of a pediatric phantom for dosimetry in CBCT

Ladyjane Pereira Fontes Assemany ,Orlando Rodrigues Júnior and Maria da Penha Albuquerque Potiens

Instituto de Pesquisas Energéticas e Nucleares, IPEN-CNEN/SP. Av. Professor Lineu Prestes, 2242, Cidade Universitária – 05508000. São Paulo – SP – Brazil.

Cone-beam computed tomography (CBCT) has been widely used in orthodontics, due to the ability to provide visualization of mineralized tissues in high definition and consequently the identification and delimitation of three-dimensional irregularities. Compared with 2D imaging techniques, the doses used in CBCT exams are higher [1].

Considering that the pediatric and adolescent population routinely receives orthodontic treatments, it is important to note that the cellular development phase of the organs is associated with increased tissue sensitivity to radiation, and that cancer is one of the main long-term effects caused by exposure to X radiation [2, 3].

In recent years the 3D printing technique has been used in the medical industry because it allows the reproduction of structures of the human body, enabling detailed studies in several application areas. The objective of this work was to study the different types of filaments available for 3D printing of structures that will compose a phantom for dose evaluation in the pediatric and adolescent population who undergo CBCT exams. Were printed cylinders of PLA, ABS and PLA with aluminum metal load filaments, with 10 cm long, 5 cm external diameter and 10.5 mm internal diameter for accommodating the pencil-type ionization chamber. The materials were tested in RQT 8, 9 and 10 radiation qualities reference beams to obtain entrance surface air Kerma rates, and the values were compared with the PMMA phantom values available in the literature. For evaluation in clinical beams, tests were performed with the materials in an computed tomography equipment to evaluate the equivalence of the materials to human tissues by the Hounsfield scale. The results showed higher equivalence for cylinders printed with PLA and PLA with aluminum metal load.

Keywords: 3D Printing, cone-beam computed tomography, dosimetry.

[1] Kapila S, Conley RS, Harrel WE Jr., The current status of cone beam computed tomography in orthodontics. Dentomaxillofac Radiol, 2011; 40:24-34.

[2] Smith-Bindman R, Lipson J, Marcus R, Kim KP, Mahesh M, Gould R, et al. Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risk of cancer. Arch Intern Med 2009;169:2078-86.

[3] Brenner D, Elliston C, Hall E, Berdon W. Estimated risks of radiation-induced fatal cancer from pediatric CT. AJR Am J Roentgenol 2001;176:289-96.